

jacent. Each course occupies from 50 to 100 hours during a term of four months and a half. Some professors go with their students through a complete course of elementary instruction, whilst others leave this chiefly to private study, devoting the greater part of their time to inducting their pupils into the method of especial research. The attendance of students at the lectures is ensured by the circumstance that the Natural Sciences form part of the objects in which medical men, chemists, and teachers, are examined before they are allowed to enter upon the exercise of their calling. We are informed that, at a University with nearly 700 students (each remaining generally eight terms), some fifty would attend, within one term, the course of Natural Philosophy, or Botany; about twenty-five that of Zoology, or Comparative Anatomy; from fifteen to twenty that of Mineralogy, or Palæontology; and about thirty-five that of Geology. These were the numbers usually seen in the lecture-rooms, but there were, of course, other students who were prevented from attendance by various causes. The majority of those students who are desirous of receiving a perfect scientific education, and have the means for it, take advantage of the great variety of collections and instructors by prosecuting their studies at two or more Universities, finishing them at those places which offer the largest collections, and, in natural combination, the best instruction.

It may be mentioned here that the teaching of Science in German Universities is not entirely dependent on the public collections. Beside the staff of "ordinary" professors, there are younger men attached to the University, who have the right to teach, but can make only such use of the collections as the ordinary professor is disposed to grant. Most of them select, for their course of lectures, branches in the teaching of which they can dispense with the collections of the Museum—as, physiology of plants, histology and microscopy, history of development, general biology. This institution of "private docents," as they are called, is valuable not only to the students, but also to the body of instructors, inasmuch as it forms a preparatory school for men who intend to undertake the duties of an ordinary University teacher. The presence of an able and popular "private docent" has also not rarely had the beneficial effect of exciting to fresh exertions the ordinary professor, who had gradually lapsed into a course of stereotyped lectures. Nevertheless this institution can be regarded only as supplementary to the system of scientific education which is principally carried out in connection with the Museums.

We are not aware that there has ever been any lack of men combining an exact knowledge of some branch of Natural History with the aptitude for teaching it; nor have we ever heard of complaints that the duties of teaching seriously interfered with those of the curatorship; on the contrary, their union in one individual can have and has had only a beneficial effect. As teacher he knows best how to regulate the accessions and modify the arrangement of the collection, so as to meet the requirements of, and to be in accordance with, his system of teaching; and as curator he takes care that those parts which are not in direct connection with the lectures are not neglected, or that valuable specimens are not sacri-

ficed for temporary purposes in the lecture-room or student's laboratory. Work in the Museum is as necessary for the training of the students as attendance in the lecture-room; and it is the duty of the teacher to devise suitable objects of research for his pupils. But if he had not the management of the collection, how could he be certain that the materials required are present, or will be made available? Would it be possible for him to superintend the student's work in a place where he is not the master? Were those duties assigned to two individuals, they would soon clash, to the injury of the service expected from the Institution.

The existence of numerous large or well-adapted collections, their utilisation for educational purposes, and the devotion of adequate time to instruction, are among the principal causes which have rendered the system of scientific education successful throughout Germany. But we must not forget that this success is due to the Universities only, and is limited to the classes receiving a University education. In the schools of lower degree, Science (with the exception of chemistry and natural philosophy) is only taught in the form of book-knowledge, in which the pupil takes but little interest, and therefore it has no great or lasting influence on the culture of his mind.

THE DESCENT OF MAN

The Descent of Man, and Selection in relation to Sex.

By Charles Darwin, M.A., F.R.S., &c. In two volumes. Pp. 428, 475. (Murray, 1871.)

II.

THAT selection in relation to sex has been an important factor in the formation of the present breeds of animals was more than indicated in the "Origin of Species," and the theory has since been especially worked out by Professor Haeckel. It includes two distinct hypotheses. One is that in contests between males, the weakest would go to the wall, and thus either be killed outright, or at least debarred more or less completely from transmitting their characters to another generation. This may be regarded as a particular case of Natural Selection, and may be compared with the theory of protection by mimicry, suggested by Mr. Bates, and carried out by him and by Mr. Wallace. But though in the lists of Love the battle is often to the strong, even more frequently it is to the beautiful. This introduces a new process, of which the effects are not nearly so obvious as those of Natural Selection, either in its simplest form or in the more complicated cases of mimicry, and of sexual selection by battle. Many circumstances must combine in order that the most successful wooers shall have a larger and more vigorous progeny than the rest. In the first place, all hermaphrodite and all sessile animals may be excluded, and also those cases in which sexual differences depend on different habits of life. Mr. Darwin then shows that secondary sexual characters are eminently variable, and that males vary more than females from the standard of the species, a standard determined by the young, by allied forms, and sometimes by the character of the male himself when his peculiar functions are only periodical, or when they have been artificially prevented. Moreover it is the males who take the active part in pairing, and who not only fight for the possession of their mates, but display their colours, their voice, or whatever

be their peculiar attractions, in order to gain the same end. This rule is confirmed by the exceptional case of the cassowary and a few other species in which the hens court the male birds, fight together in rivalry, and accordingly assume the brighter colours and more attractive shape usually worn by the male. Not only the parental and incubating instincts, but the usual moral qualities of the two sexes are in these cases reversed: "the females being savage, quarrelsome, and noisy, the males gentle and good." But it is further necessary to show that the females exert a choice among the males, and that the latter are polygamous, or arrive earlier at the place of pairing, as is the case with some birds, or else exceed in numbers, at least when both sexes are mature. On this point a series of observations is recorded relating chiefly to man, to domesticated mammals, and to insects. The rule as to transmission of male characters to both sexes appears to be that when variations appear late in life they are usually developed in the same sex only of the next generation, although they are, of course, transmitted in a latent condition through both; while, on the other hand, the differences which appear before maturity in the

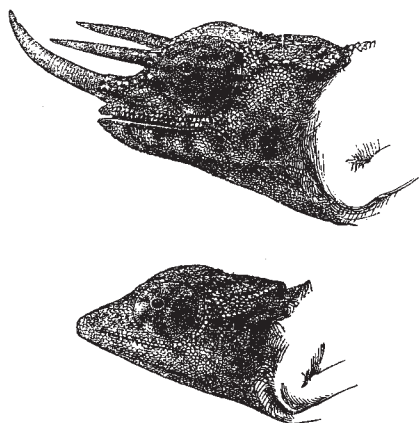


FIG. 2.—*Chamaeleon Owenii*. Upper figure, male; lower figure, female.

parent are equally developed in both sexes when transmitted to the offspring. The numerous apparent exceptions to these laws of inheritance and of sexual selection are examined with wonderful fairness and fertility in resource. I may particularly refer to the discussion of the ways in which the young and adults of both sexes differ among birds. The extreme intricacy of some of the questions considered is best shown by a postscript in which, with characteristic candour, the author corrects "a serious and unfortunate error" in the eighth chapter.

The remainder of the first and the greater portion of second volume are occupied by a survey of sexual variations throughout the animal kingdom. Passing rapidly over the other invertebrate classes, the author devotes two chapters to the secondary sexual characters of insects. The weapons, the ornaments, and the sounds peculiar to the males of this vast group of animals are briefly described, and the remarkable analogy between insects and birds which is seen in so many other particulars is traced here also. The brilliant colours of many caterpillars, which, of course, cannot be due to sexual selection, offer one of the many difficulties which are faced, and this

is explained by the aid of what the author terms Mr. Wallace's "innate genius for solving difficulties," as being due to natural selection. The bright colours warn the enemies of the caterpillars that they are unfit for food, and so benefit the latter, "on nearly the same principle that certain poisons are coloured by druggists for the good of man." Many cases are probably further complicated by mimicry, savoury caterpillars assuming the colours of distasteful ones so as to share in their immunity, in the same way that a druggist might label his bottles of sweetmeats "poison," to keep them from the shop-boy.

In the frigid classes of the lower Vertebrata one would think that sexual selection would have little play; yet Mr. Darwin gives several instances among fishes, amphibians, and reptiles in which weapons or ornaments, peculiar to the males, appear to have been acquired by this means. (See Fig. 2.) But it is in the great class of birds that the most complete series of examples is found, and our advanced knowledge of the habits of this class renders it

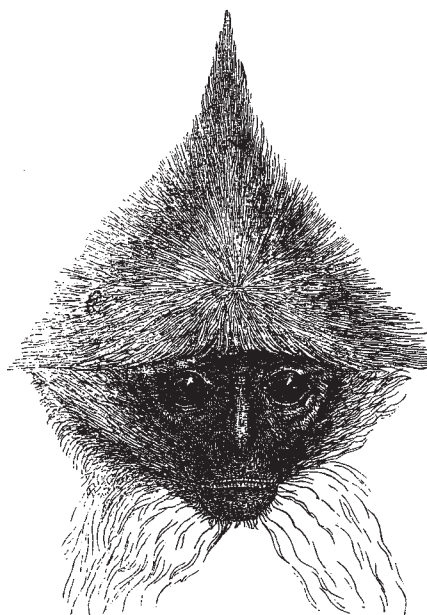


FIG. 3.—Head of *Semnopithecus rubicundus*. This figure (from Prof. Gervais) is given to show the odd arrangement and development of the hair on the head.

the best possible field for the exposition of the whole theory. Again and again our author forestalls the evidence adduced in the chapters on sexual selection among birds, when tracing its first obscure operation among lower classes, and falls back on the same stronghold when explaining its less obvious working in the mammalia.

Among birds the rivalry of beauty has led to far more striking results than has the rivalry of strength. Foremost of these is the power of song, which, in accordance with the law of the least waste, is usually confined to birds of inconspicuous colours, while the combination of the harsh note with the magnificent plumage of the peacock is a familiar converse example. The object of the adornment of birds is conclusively proved by its being, as a rule, confined to males, and often to them only during the breeding season, as well

as by the pains they take to exhibit their beauties to the hens. The difficulty is to show the precise way in which the results have been attained by gradual selection. In two remarkable instances, the wings of the Argus pheasant and the train of the peacock, Mr. Darwin succeeds in tracing the gradations in the same bird or the same family by which these wonderful and elaborate ornaments have been brought to their present perfection. The woodcuts which illustrate these gradations are unfortunately too numerous to be reproduced here; they are admirably drawn, and convey the impression of the feathers as nearly as is possible by the means employed. Indeed, we may here remark that throughout these volumes the original cuts, generally of details of structure, contrast very favourably with the figures of species taken from Brehm's "Thierleben," which are feebly drawn and ill-engraved.

Sexual selection has, of course, been continually checked and modified by the never-ceasing influence of natural selection, sometimes, as in the case of the horns of stags, being only somewhat diverted, but often directly opposed, as when it produces dangerously conspicuous colours, and dangerously cumbersome ornaments. In the case of birds, Mr. Darwin holds that the usual tendency of sexual selection being to produce variation in males, its transmission to hen birds has been checked by natural selection. Mr. Wallace, on the other hand, believes that both tendencies have generally operated together, in opposite directions, so as to make successive generations of males more and more conspicuous than the primitive type, and those of females less so. The fact that, as a rule, young birds resemble hens in their plumage, is a strong argument for the former opinion, since most naturalists admit that early characters are the most trustworthy guide to natural alliances, *i.e.*, to true genealogy. To explain the transmission in some cases of brilliant colours (acquired probably by sexual selection, and therefore properly a male character) to both sexes indiscriminately, Mr. Wallace has framed the ingenious hypothesis, that the females have been protected from the dull uniformity threatened by natural selection, by their very general habit of building covered nests. Our author looks at the facts in a reversed way, and supposes that in most cases these hen birds, having inherited bright colours from the males, were led to the habit of building covered nests for the sake of protection.

Among mammals sexual selection has chiefly operated by increasing the size and strength of the males, and furnishing them with weapons of offence;* but besides allurements to the senses of smell and hearing, this class offers not a few instances, especially among the Quadrumana, of brilliant colouring being developed as a secondary sexual character. Here also we have the most striking instances of the production of defensive organs by the same process, as in the manes of lions, the cheekpads of some of the *Quida*, and possibly the upper tusks of that ancient enigma, the *barbirusa*. Lastly, it is in the class of mammals that we meet with cases of what may be called primary sexual ornament, as in *Cercopithecus cynosurus*, which make one wonder, with a thankful wonder, why such apparently obvious results are not

more common. We must, however, admit that such adornment is not more disgusting, nor that of which we copy a figure more ludicrous, than the personal decorations of savages. Sir Joshua Reynolds says that if a European in full dress and pigtail were to meet a Red Indian in his warpaint, the one who showed surprise or a disposition to laugh would be the barbarian.* But who could stand this test when meeting *Semnopithecus rubicundus* or *Pithecia satanas*?

We must admit, notwithstanding such anomalies, that, on the whole, birds and other animals admire the same forms and colours which we admire, and this, perhaps, may be admitted as an additional argument in favour of their kinship with us. Some of the ugliest creatures (like the hippopotamus) appear to have been quite uninfluenced by sexual selection, while the magnificent plumes of pheasants and birds of paradise are undoubtedly due to its operation. That it has occasionally led to unpleasing results in birds and monkeys of aberrant taste, is no more strange than that all savages do not carve and colour as well as the New Zealanders, or that most Englishmen admire ugly buildings and vulgar pictures. The prevailing aspect of nature is beauty, and the prevailing taste of man is for beauty also. The means by which natural beauty has been attained are various. Natural selection is one, by which the healthiest, and therefore the most symmetrical forms survive the rest. Protective mimicry is another, by which fishes have assumed the bright colours of a coral garden and butterflies the delicate venation of leaves. Flowers again have in many cases obtained their gay petals and fantastic shapes from the advantage thus gained for fertilisation by insects. The successive steps which have led to the graceful forms and brilliant tints of shells, to the intricate symmetry of an echinus-spine or a nummulite, these are as yet untraced even in imagination.

But that many of the most striking ornaments of the higher animals, and almost all those which are peculiar to one sex, have been developed by means of sexual selection, is a conclusion which can no longer be distrusted. There remain doubtless many exceptions to be accounted for, many modifying influences to be discovered; but the existence of a new principle has been established which has helped to guide the organic world to its present condition. Side by side with the struggle for existence has gone on a rivalry for reproduction, and the survival of the fittest has been tempered by the success of the most attractive.

P. H. PYE SMITH

HELMHOLTZ'S TONEMPFINDEUNGEN

Die Lehre von den Tonempfindungen, von H. Helmholtz. (Braunschweig: F. Vieweg. London: Williams and Norgate. 3rd edition. 1870.)

THIS work traces the connection between physical and physiological acoustics, on the one hand, and the general principles and practice of music, on the other. Professor Helmholtz's qualifications for taking up this subject are unique. In each branch of science involved in the inquiry he has a reputation at least equal to that of any specialist in that branch. In the combination of eminently original mathematical power and consummate

* The very general transmission of such weapons to both sexes may, perhaps, be explained by the need females have of means to defend their young.

* Discourse delivered at the Royal Academy, December 10, 1776.